180134

FLOOD INSURANCE STUDY

CITY OF HAMMOND, INDIANA

LAKE COUNTY

SEPTEMBER 16, 1980

federal emergency management agency
federal insurance administration

COMMUNITY NUMBER - 180134

FEMA 209

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Flood Boundary and Floodway Map

PUBLISHED SEPARATELY:

Flood Insurance Rate Map Index
Flood Insurance Rate Map

FLOOD INSURANCE STUDY

CITY OF HAMMOND,
LAKE COUNTY, INDIANA

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the City of Hammond, Lake County, Indiana, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study will be used to convert the City of Hammond to the regular program of flood insurance by the Federal Insurance Administration (FIA). Local and regional planners will use this study in their efforts to promote sound flood plain management.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than those on which these Federally-supported studies are based. These criteria take precedence over the minimum Federal criteria for purposes of regulating development in the flood plain, as set forth in the Code of Federal Regulations at 44 CFR, 60.1 (d). In such cases, however, it shall be understood that the state (or other jurisdictional agency) shall be able to explain these requirements and criteria.

1.2 Authority and Acknowledgements

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were performed by the U.S. Army Corps of Engineers, Chicago District, for the Federal Insurance Administration, under the Inter-Agency Agreement No. IAA-H7-76, Project Order No. 19. This study was completed in September 1978.

1.3 Coordination

The selection of the community base map and the identification of streams to be studied in detail was done at a meeting attended by representatives of the U.S. Army Corps of Engineers (COE), the FIA, and the City of Hammond. All peak flood discharges used in this study have been reviewed and approved by the U.S. Geological Survey (USGS), the U.S. Department of Agriculture, Soil Conservation Service (SCS), and the Indiana Department of Natural Resources. The initial meeting was held January 5, 1976. During the course of this study, flood elevations, flood boundaries, and floodway

delineations were reviewed with officials from the community and from the Indiana Department of Natural Resources.

On April 10, 1980, the results of the work by the Study Contractor were reviewed and accepted at a final coordination meeting attended by personnel of the COE, the FIA, the Indiana Department of Natural Resources, and the City of Hammond.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the City of Hammond. The area of study is shown on the Vicinity Map (Figure 1).

The areas studied by detailed methods were selected with priority given to all known flood hazard areas, and areas of projected development or proposed construction through April 1981.

Approximate methods of analysis were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to and agreed upon by the FIA and the City of Hammond.

The flooding sources studied by detailed methods are listed below:

a. Grand Calumet River within the corporate limits;

b. Little Calumet River within the corporate limits; and

c. Lake Michigan shoreline within the City of Hammond.

Flooding in the Wolf Lake Park Area, the Lake George Area, and the Lake George Canal Industrial Area was studied by approximate methods.

2.2 Community Description

The City of Hammond, located in the northwest corner of Lake County, is in northwest Indiana. It is 19 miles south-southeast of the Chicago Loop. Hammond is bordered by Lake Michigan on the north; Gary, East Chicago, and Whiting on the east; Highland on the south; and Chicago, Burhnam, and Calumet City, Illinois, on the west.

A community was founded at Hammond in 1851. The community was later named for George Henry Hammond who established a meat packing plant here in 1868. Hammond was incorporated in 1884. The 1970 census lists the population of Hammond as 107,885, a decrease of 3.4 percent from the 1960 population of 111,698 (Reference 1). Present land uses in Hammond are

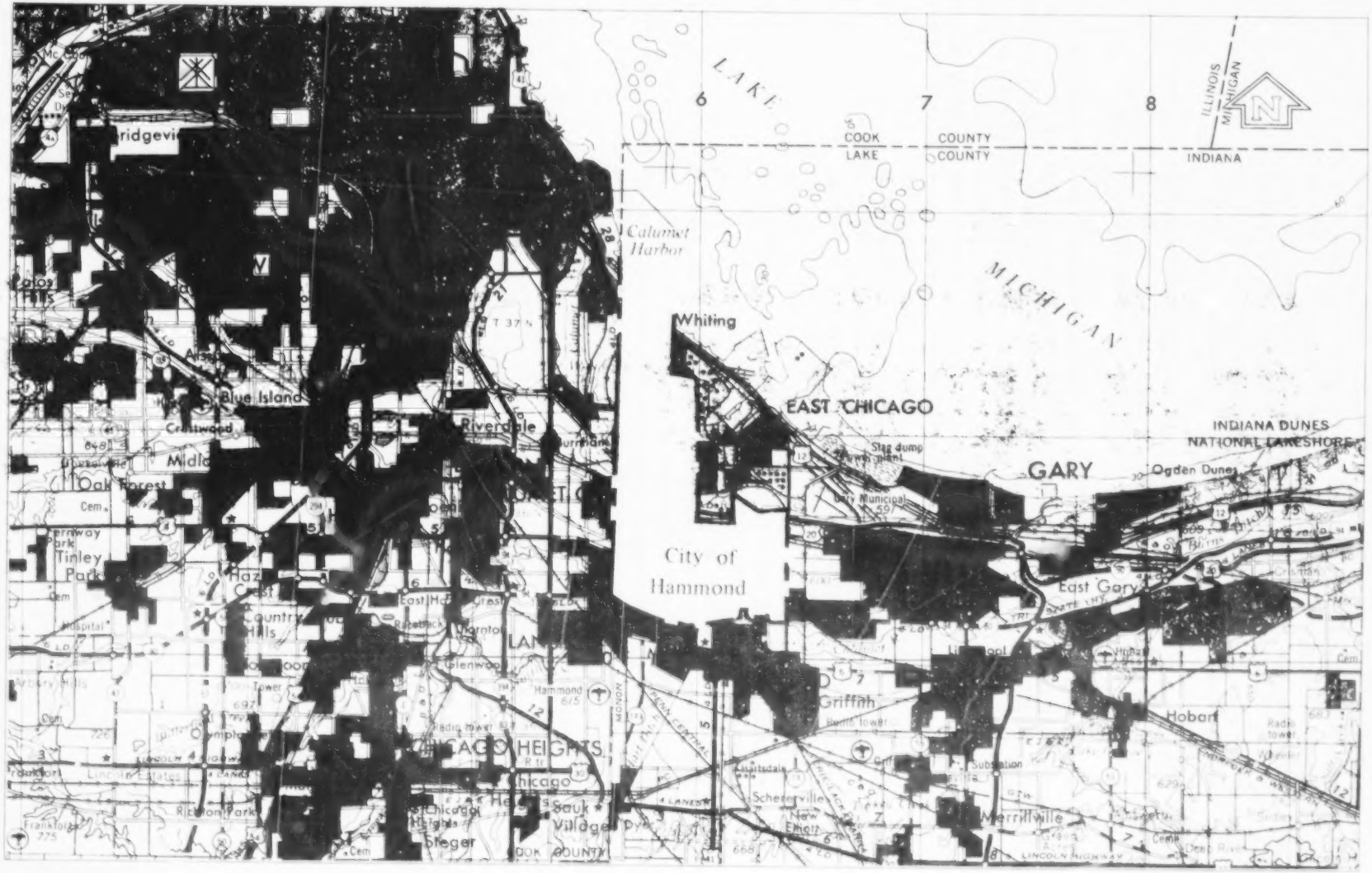

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

Federal Insurance Administration

CITY OF HAMMOND, IN

(LAKE CO.)

APPROXIMATE SCALE

4 0 4 8 12 MILES

VICINITY MAP

primarily industrial and residential with some commercial and open space uses evident. Hammond is a major transportation center with three interstate highways and numerous railroads. Although Hammond is surrounded by huge steel plants and oil refineries, its economy depends on about 200 small industries. The principal products include books, soap, margarine, corn products, steel forgings, railroad equipment, chains, steel and fiber containers, and candy (Reference 2).

Monthly average temperatures for the Hammond area vary from a low of 24.7 degrees Fahrenheit (F.) in January to a high of 69.6 degrees F. in July. Annual precipitation averages 50.3 inches per year (Reference 3).

The topography of Hammond is very flat, with a maximum relief of 25 feet within the city. The principal physiographic features of the Little Calumet River basin are a result of the latest glaciation from the Lake Michigan lobe of the Wisconsin ice sheet. As this glacier receded several moraines were deposited, the most significant of these being the Valparaiso Moraine which parallels the Lake Michigan shore and forms the southern boundary of the Little Calumet River watershed. The bedrock in the Little Calumet basin is of sedimentary origin, the uppermost units being comprised of limestone and dolomite of the Niagrian seris, Silurian system (Reference 4). Soils in the basin are generally sands and scattered muck deposits underlain by massive glacial till sheets having a silty clay composition (Reference 5). Because of the limited topographic relief in the Hammond area, several wetland areas overgrown with thick grass and low-lying brush can be found. These wetlands exemplify the general sluggishness of the Little Calumet River basin in discharging runoff.

The Little Calumet River rises in western LaPorte County, Indiana, and encompasses a total drainage area of approximately 587 square miles. Originally, the entire river drained to the west past the Illinois-Indiana state line, then made a sharp curve to the northeast back into Indiana, and eventually emptied into Lake Michigan at present Marquette Park in Gary. About 170 years ago the Indians opened a new channel to Lake Michigan just east of the state line. Eventually the original mouth at Gary became clogged with vegetation and sand, causing this portion of the river, now called the Grand Calumet River, to flow westward to the new mouth. The Calumet-Sag Channel was dug in 1922, partially to prevent pollution to the lake from this reverse flow; hence flow from the Little Calumet River west of Hart Ditch empties into the Calumet-Sag Channel and continues westward to the Chicago Sanitary and Ship Canal.

The flood plain has residential and industrial development in the Grand Calumet River drainage area. Along the Little Calumet River development is mostly residential with some open space.

2.3 Principal Flood Problems

The Little Calumet River, the major source of flooding in Hammond, is subject to floods as a result of heavy runoff from its tributaries. Snowmelt over the basin in the spring causes the streams to rise, and the flat, low-lying portions of the Little Calumet River Valley are flooded for several days or, in some instances, for weeks. Prolonged flood duration is also caused by inadequate channel capacity which forces most of the water into temporary storage. Major floods have occurred in March 1908, March 1944, April 1947, March 1948, May 1948, October 1954, and July 1957. Lesser floods have occurred in 68 other instances since 1907. No flood recurrence intervals are available.

Flooding from Lake Michigan is caused by a combination of high lake levels and the wind setup effect. The Grand Calumet River does not have a major flooding problem because most of the flow in the river is industrial cooling and process water and waste treatment plant effluents.

Past floods in Hammond have caused extensive damage to residential, commercial, and public properties. These damages include foundation and basement damage due to hydraulic pressures and settling, deposition of debris, silt, and slime, and water damage to buildings, contents, and grounds. A health hazard is created by the backup of sanitary sewers. Hazard to life is minimal since flooding is shallow, although failure of a large spoil bank could catch people off guard and prove disastrous. Figures 2 through 6 show views of past floods in the City of Hammond. In October 1954 National Guard Troops were called into Hammond to aid volunteers in the flood relief effort. The Little Calumet River broke through a sandbag dike in three places. About 400 residents of the Schleicher addition were evacuated. Total damages from this flood were estimated at $2,320,000.00 (Reference 6). The flood problems in the Little Calumet River basin arise from both stream overflow and inadequate storm drainage systems. The damage due to the latter condition can be corrected only by major reconstruction of existing storm drains, the installation of sump pumps in individual basements, and extensions of storm drains to those areas which now do not have any. The flood problem in conplicated by the extreme flatness of the area causing sluggish passage of floodwaters. The large amount of development in this basin has left little space for the construction of flood protective works. This development has also increased the amount of hard surface area, such as roads, sidewalks, and roofs, causing greater storm runoff. Channel constrictions, such as bridges with insufficient floodway area, collect debris and inhibit the passage of floodwaters. Another problem is created by spoil banks which were built without allowing sufficient channel capacities resulting in increased flood stages.

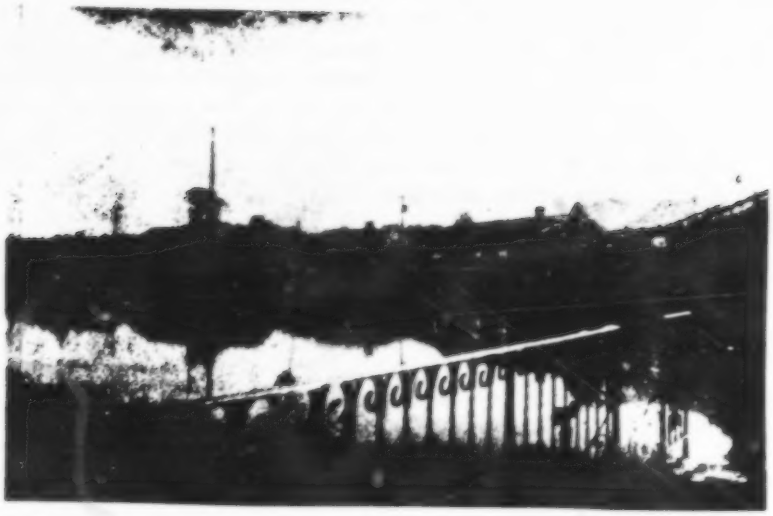

FIGURE 2 - Looking east along Bertram Avenue during the 1954 flood in Hammond, Indiana.

FIGURE 3 - Looking east along Bertram Avenue on April 1, 1963 in Hammond, Indiana.

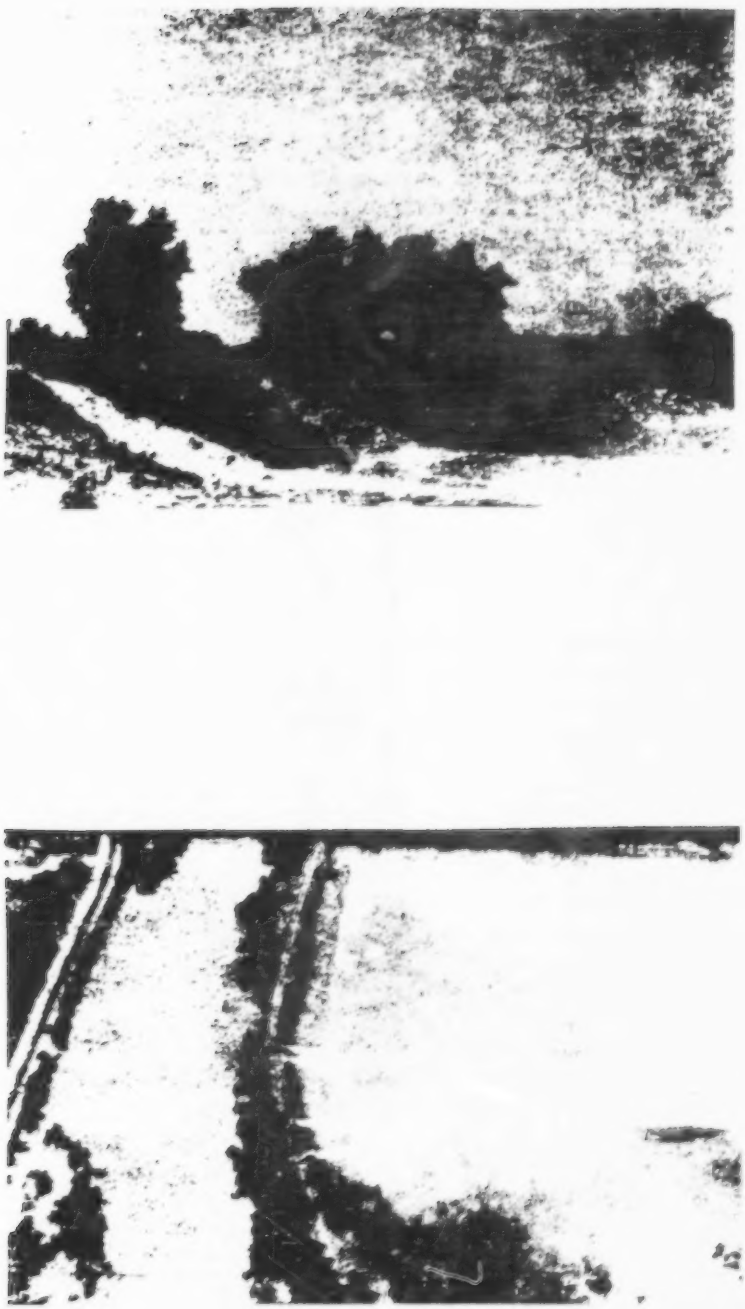

FIGURE 5 - Looking west along the Little Calumet River from a point above Kennedy Avenue during the 1957 flood. Note the failures in the Hammond Spoil Bank.

FIGURE 6 - The Woodmar Country Club area in Hammond, Indiana, during the flood of October 1954.

2.4 Flood Protection Measures

Measures have been taken to decrease future flood losses in Hammond. Between 1933 and 1936, a Works Progress Administration project sponsored by Gary and Hammond cleaned, deepened, and widened the Little Calumet River. In 1943, the Little Calumet River Drainage Association spent $50,000 for further enlargement of the river channel between Indianapolis Boulevard and the Illinois-Indiana state line and the construction of a relief outlet channel for Hart Ditch. In 1948, the Hammond Sanitary District modernized pumping facilities at seven storm sewer outfalls to the Little Calumet River and constructed a levee-like system along the banks at a cost of $330,000. Numerous small spoil banks have been built at various times, though such spoil banks usually afford protection against only lesser floods. In addition, there are also unauthorized and private spoil bank constructions that are too numerous to locate to determine their effects during a flood event. The zoning ordinace of the City of Hammond allows open area use such as agriculture, public parks, playgrounds, and recreation areas in the flood prone areas. Single family residences are permitted on the condition that the owner provides a system of adequate flood protective works approved by the City of Hammond and the Indiana Flood Control and Water Resources Commission, Hammond Ordinance Number 2992 concerning Subdividing Real Property which requires the minimum elevation of residential streets to be 596 feet. Sites for residential structures must be one foot above curb level.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equalled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance premium rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equalled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than one year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (one percent chance of annual occurrence) in any 50-year period is about 40 percent (four in ten), and for any 90-year period, the risk increases to about 60 percent (six in ten). The analyses reported here reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for floods of the selected recurrence intervals for each flooding source studied in detail affecting the community.

The Little Calumet River hydrology is affected by many complicating factors, such as (1) split flow direction at Hart Ditch and Deep River; (2) large reduction of low as the floodwaters proceed downstream and spread over a large area; and (3) numerous spoil bank and other types of construction which inhibit the passage of floodwater and remove storage volume. The HEC-1 computer model (Reference 7) was chosen to develop the basin hydrology.

The HEC-1 model relates basin characteristics and rainfall data to stream discharge. The basin characteristics include vegetation, topography, amount and nature of development, and soil types. Rainfall data was generated by a statistical analysis of rain gage records. Six-hour increments of a 24-hour storm rainfall, corresponding to frequencies of 10-, 50-, and 100-years were obtained from the National Weather Service Technical Paper No. 40 (Reference 8). Rainfall values for the 500-year storm were then extrapolated from values for the lower three frequencies. Sets of these rainfall increments were entered into the HEC-1 model, in critical order, to obtain peak discharges for the 10-, 50-, 100-, and 500-year floods.

The modified Puls routing method reduced the flows in the stream to compensate for the large quantities of water which will be stored in the overbank areas. This flow reduction was based on storage-discharge relationships developed from the HEC-1 hydrologic analysis.

The proportioning of the split flows for Hart Ditch was done by analyzing gage records on Hart Ditch and the Little Calumet River. The periods of record for the gages are 20 years for the gage at the Little Calumet in Munster (no. 4-0876) and 36 years for the gage near the mouth of Hart Ditch (no. 4-0875). Flow records were statistically analysed using log-Pearson Type III distributions with expected probability. Discharge-frequency curves were developed using the regional skew of -0.2 recommended by the State of Indiana.

The HEC-1 model was also used to develop discharge values for the Grand Calumet River.

Peak discharges for the 10-, 50-, 100-, and 500-year floods of each flooding source studied in detail in the community are shown in Table 1.

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA SQ MILES	PEAK DISCHARGES (CFS) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
GRAND CALUMET RIVER					
Cline Avenue	18.13	2,940	3,340	3,588	4,020
Kennedy Avenue	22.26	3,090	3,590	3,765	4,195
Sohl Avenue	3.4	415	460	470	500
Illinois State Boundary	3.6	415	460	470	500
LITTLE CALUMET RIVER*					
Illinois State Boundary	76	1,015	1,330	1,450	1,635
Confluence with Hart Ditch	71	970	1,150	1,210	1,380
Kennedy Avenue	72	1,230	1,950	2,165	2,875
Cline Avenue	76	1,195	1,335	1,390	1,520

*Drainage areas are approximate due to interbasin flow on the Little Calumet River

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of the streams in the community were carried out to provide estimates of the elevations of the floods of the selected recurrence intervals along each flooding source studied in detail.

Cross section data for streams in the area were obtained from field surveys. All bridges and culverts along the streams studied in detail were surveyed to obtain elevation data and structural geometry.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

Roughness coefficients (Manning's "n") were estimated from field inspections at cross section locations and from model calibrations used on high water marks. Roughness values for the Little Calumet River range from 0.025 to 0.035 in the main channel and from 0.07 to 0.09 in the overbanks. Roughness values for the Grand Calumet River range from 0.03 to 0.035 in the main channel and from 0.045 to 0.06 in the overbanks.

The elevation of the headwaters from the Indiana Harbor Canal for the flood with a corresponding frequency of occurrence was used as the starting elevation for the eastern reach of the Grand Calumet River. The central reach of the river was treated as a lake in the HEC-2 computer model due to the extremely low stream velocities and the unpredictability of the direction of flow. The starting water-surface elevations for the west reach were water-surface elevations at the state line computed for the Calumet City, Illinois, Flood Insurance Study (Reference 9). The section of the Little Calumet River considered in this study flows east from Hart Ditch to Deep River and west from Hart Dtich to the state line during flood conditions.

Rating curves were developed for the gages on the Little Calumet River west of the confluence with Hart Ditch. Storm hydrographs were statistically developed at the gage on Hart Ditch in Munster. The discharges at the gages were used to compute stages to use as starting water-surface elevations for the HEC-2 step-backwater computer model (Reference 10). An iterative process was used to balance the HEC-1 storage-discharge relationship and the HEC-2 stage-storage-discharge relationship and the HEC-2 stage-storage-discharge relationship at the point where Hart Ditch empties into the Little Calumet and flows in both directions in the Little Calumet. This process included eight points of flow reduction on the east-flowing part of the river. These flow reductions are cuased by the large amounts of overbank storage of floodwaters. When stage and discharge values at the three gages agreed with statistical analyses, stages for the east- and west-flowing parts of the Little Calumet

River are congruent at their headwaters, and the combined flow for the two parts of the Little Calumet River at the split equals the Hart Ditch inflow, the model was considered a good representation of the flood event. This method was used independently for the analysis of the 10-, 50-, 100-, and 500-year flood events, since the split in flows from Hart Ditch varies greatly with the magnitude of the flood.

Water-surface profiles were computed through use of the COE HEC-2 step-backwater computer program (Reference 10). The unusual flow pattern on the Grand Calumet River made it necessary to divide the river into three separate reaches and analyze each reach individually. THe east reach begins in eastern Gary and flows west into the Indiana Harbor Canal. Because of the flat terrain between Indiana Harbor Canal and Columbia Avenue, a ponding effect occurs, and, depending upon how a storm event occurs, the Grand Calumet River can start flowing west from different locations in this area.

Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals (Exhibit 1). The reach between Columbia Avenue and the Illinois-Indiana state line flows west into the Little Calumet River.

Flood elevations for flooding along the Lake Michigan shoreline were computed by the Detroit District COE (Reference 11). Wave runup caused by storm waves meeting the shore is not included in the open coast flood levels discussed in this study. Historic records of water levels on Lake Michigan have been gathered at seven gaging stations, the closest one being at Calumet Harbor (no. 04092550). The periods of record vary from 14 to 74 years. Frequency curves of the adjusted annual flood levels at all the gaging stations were computed analytically by use of the moments of the levels: the mean, standard deviation, and skew coefficient. Using a skew coefficient of zero, the 10, 2, 1, and 0.2 percent values from the log-Pearson Type III frequency curve were computed for the 10-, 50-, 100-, and 500-year flood levels at each station. These flood elevations are listed in Table 2.

TABLE 2 - SUMMARY OF ELEVATIONS

LOCATION	ELEVATIONS (NGVD)			
	10-YEAR	50-YEAR	100-YEAR	500-YEAR
LAKE MICHIGAN				
At Hammond	583.0	583.9	584.2	584.8

Flood sources studied by approximate methods - the Lake George area, the Lake George Canal Industrial area, and the Wolf Lake Park Area - were

previously studied by the USGS using Flood Prone Maps (Reference 12), and, because of low velocities and shallow flooding, this information was considered sufficient for inclusion in this study.

The hydraulic analyses for this study are based only on the effects of unobstructed flow. The flood elevations as shown on the profiles are, therefore, considered valid only if hydraulic structures, in general, remain unobstructed and if channel and overbank conditions remain essentially the same as ascertained during this study.

All elevations are referenced from National Geodetic Vertical Datum of 1929 (NGVD); elevation reference marks used in the study are shown on the maps.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages state and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study includes a flood boundary map designed to assist communities in developing sound flood plain management measures.

4.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the FIA as the base flood for purposes of flood plain management measures. The 500-year flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the boundaries of the 100-year and the 500-year floods have been delineated using the elevations determined at each cross section; between cross sections the boundaries were interpolated using aerial photographs with a scale of 1:4800 and a contour interval to two feet (Reference 13). Delineation of the 100-year flood for flooding sources studied by approximate methods was based on information from the USGS Flood Prone Area Maps (Reference 12) and the Flood Hazard Boundary Map (Reference 14).

The boundaries of the 100- and 500-year floods are shown on the Flood Boundary and Floodway Map (Exhibit 2). Small areas within the flood boundaries may lie above the flood elevations and, therefore, not be subject to flooding; owing to lack of detailed topographical information or to limitations of the map scale, such areas are not shown. In cases where the 100-year and the 500-year flood boundaries are close together, only the 100-year boundary has been shown.

Certain areas shown on the Flood Hazard Boundary Map (Reference 14) were determined to be areas of minimal flooding and, as such, have not been included on the Flood Boundary and Floodway Map and the Flood Insurance Rate Map.

4.2 Floodways

Encroachment on flood plains, such as artificial fill, reduces the flood-carrying capacity, increases the flood heights of streams, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, the concept of a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent flood plain areas that must be kept free of encroachment in order that the 100-year flood may be carried without substantial increases in flood heights. Minimum standards of the FIA limit such increases in flood heights to 1.0 foot, provided that hazardous velocities are not produced.

The State of Indiana, however, as set down by the Indiana Flood Control Act of 1945 and the Natural Resources Commission Policy Guidelines, Section 6, adopted March 29, 1974 (Reference 15), has designated that encroachment in the flood plain is limited to that which will cause no significant increase in flood height. As a result, no more than a 0.1-foot surcharge has been delineated for this study. The floodways shown in this report were approved by the Indiana State Natural Resources Commission when the review process was completed.

The floodway recommended for this study was computed on the basis of equal conveyance reduction from each side of the flood plain. The results of these computations were tabulated at selected cross sections of each stream segment for which a floodway was computed (Table 3).

The standard conveyance floodway is not considered reasonable for the Little Calumet River becasue the area is flat and the flood plain is large. Encroachments into the flood plain would reduce the overbank storage of floodwaters and raise the downstream discharges and water-surface elevations long before it would effect the conveyance of floodwater. West of the confluence with Hart Ditch, the floodway will be delineated on the high spoilbanks along the river. These spoilbanks lack the structural soundness to offer protection from a major flood event, but they are considered to have hydraulic significance. Since all the water that breaches the spoilbanks would be standing water, and since the land behind the spoilbanks is now fully developed, it was decided that the most reasonable floodway delineation would be along these spoilbanks. East of the confluence with Hart Ditch, no floodway is delineated. No detailed floodway was considered the best solution for this area because a computed floodway based on storage reduction was not feasible.

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway boundaries were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the boundaries of the floodway and the 100-year flood are either close together or collinear, only the floodway boundary has been shown.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE
GRAND CALUMET RIVER							
A	2.972	264	772	0.6	582.6	582.5	0.1
B	3.177	103	419	1.1	583.6	583.5	0.1
C	3.466	119	655	0.4	584.6	584.5	0.1
D	3.734	219	891	0.3	584.6	584.5	0.1
E	4.216	231	1131	0.2	584.9	584.8	0.1
F	6.896	340[2]	3336	1.1	585.3	585.2	0.1
G	7.327	802[2]	3937	0.9	585.4	585.3	0.1
H	7.522	716[2]	3148	1.1	585.5	585.4	0.1
I	7.971	230[2]	1620	2.2	585.8	585.7	0.1
J	8.312	456[2]	2394	1.5	586.2	586.1	0.1
K	8.624	413[2]	2174	1.6	586.5	586.4	0.1

[1] MILES ABOVE MOUTH
[2] THIS WIDTH EXTENDS BEYOND CORPORATE LIMITS

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration
CITY OF HAMMOND, IN
(LAKE CO.)

FLOODWAY DATA

GRAND CALUMET RIVER

The area between the floodway and the boundary of the 100-year flood is termed the floodway fringe. The floodway fringe thus encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 0.1 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 7.

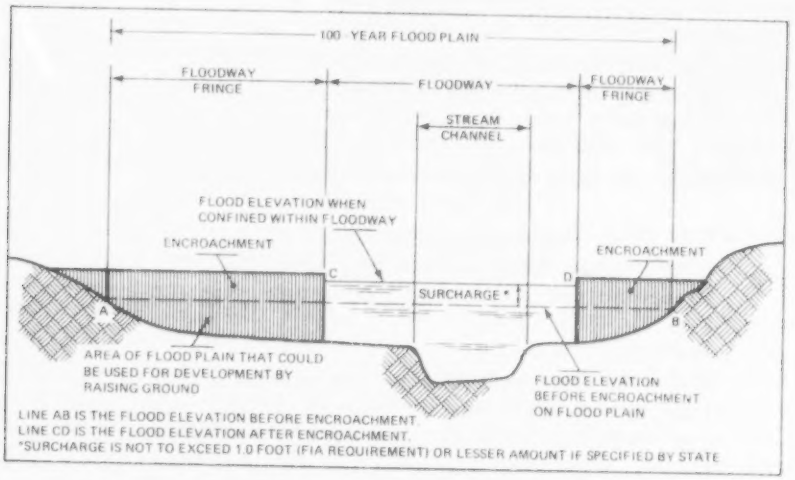
100-YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE *
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT.
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT.
*SURCHARGE IS NOT TO EXCEED 1.0 FOOT (FIA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE

FIGURE 7 - Floodway Schematic

The floodways in this report are recommended to local agencies as minimum standards that can be adopted or that can be used as a basis for additional studies.

5.0 INSURANCE APPLICATION

In order to establish actuarial insurance rates, the FIA has developed a process to transform the data from the engineering study into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors (FHF), and flood insurance zone designations for each flooding source affecting the City of Hammond.

5.1 Reach Determinations

Reaches are defined as lengths of watercourses having relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference does not have a variation greater than that indicated in the following table for more than 20 percent of the reach.

Average Difference Between 10- and 100-year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the City of Hammond are shown on the Flood Profiles (Exhibit 1) and are summarized in the Flood Insurance Zone Data Table (Table 4).

5.2 Flood Hazard Factors

The FHF is used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their FHFs are used to set actuarial insurance premium rate tables based on FHFs from 005 to 200.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations expressed to the nearest 0.5 foot, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year water-surface elevations is greater than 10.0 feet, accuracy for the FHF is to the nearest foot.

5.3 Flood Insurance Zones

After the determination of reaches and their respective FHFs, the entire incorporated area of the City of Hammond was divided into zones, each having a specific flood potential or hazard. Each zone was assigned one of the following flood insurance zone designations:

Zone A: Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations are shown or FHFs determined.

Zones A2, A3, A5: Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations are shown, and zones subdivided according to FHF.

Zone B: Areas between the Special Flood Hazard Area and the limits of the 500-year flood, including areas of the 500-year flood plain

that are protected from the 100-year flood by dike, levee, or other water control structure; or areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.

Zone C: Areas of minimal flooding.

Table 4, "Flood Insurance Zone Data," summarizes the flood elevation differences, FHFs, flood insurance zones, and base flood elevations for each flooding source studied in detail in the community.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the City of Hammond is, for insurance purposes, the principal result of the Flood Insurance Study. This map (published separately) contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. This map is developed in accordance with the latest flood insurance map preparation guidelines published by the FIA.

6.0 OTHER STUDIES

Flood Insurance Studies are currently in progress for the adjacent City of Gary, Indiana; the Town of Munster, Indiana; the City of East Chicago, Indiana; the Town of Highland, Indiana; and the unincorporated areas of Lake County, Indiana (References 16, 17, 18, 19, and 20). The results of these studies agree with the results of the Hammond study at the Hammond corporate limits. At the corporate limits of Hammond, Indiana, and Calumet City, Illinois (Reference 9), the Little Calumet River has an increase of more than one foot. The reason for this is because the two states involved, Indiana and Illinois, could not agree on the hydrologic assumption to develop the elevations for a flood event. Two of the major differences are the flow for a flood event and the stage discharge relationship. A Flood Plain Information Report on the Little Calumet River and Tributaries was previously published by the COE (Reference 21). This Flood Insurance Study supersedes that Flood Plain Information Report and can be regarded as the more authoritative source information.

A Flood Hazard Boundary Map has been published by the Federal Insurance Administration (Reference 14). The differences between the Flood Hazard Boundary Map and this study are justified due to the more detailed nature of this Flood Insurance Study.

This report either supersedes or is compatible with all previous studies published on streams studied in this report and should be considered authoritative for the purposes of the National Flood Insurance Program.

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION[3]
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
GRAND CALUMET RIVER							
REACH 1	0004,0005	−0.8	−0.2	0.4	010	A2	VARIES–SEE MAP
REACH 2	0006	−0.9	−0.2	0.5	010	A2	VARIES–SEE MAP
LITTLE CALUMET RIVER–WEST							
REACH 1	0007	−2.4	−0.7	1.1	025	A5	VARIES–SEE MAP
LITTLE CALUMET RIVER–EAST							
REACH 1	0007,0008	−1.7	−0.1	0.4	015	A3	VARIES–SEE MAP
LAKE MICHIGAN							
REACH 1	0001,0002	−1.2	−0.3	0.6	010	A2	584

[1]FLOOD INSURANCE RATE MAP PANEL
[2]WEIGHTED AVERAGE
[3]ROUNDED TO NEAREST FOOT

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration
CITY OF HAMMOND, IN
[LAKE CO.]

FLOOD INSURANCE ZONE DATA

GRAND CALUMET RIVER - LITTLE CALUMET RIVER-WEST - LITTLE CALUMET RIVER-EAST - LAKE MICHIGAN

7.0 LOCATION OF DATA

Survey, hydrologic, hydraulic and other pertinent data used in this study can be obtained by contacting the Insurance and Mitigation Division, Federal Emergency Management Agency, One North Dearborn Street, Chicago, Illinois 60602.

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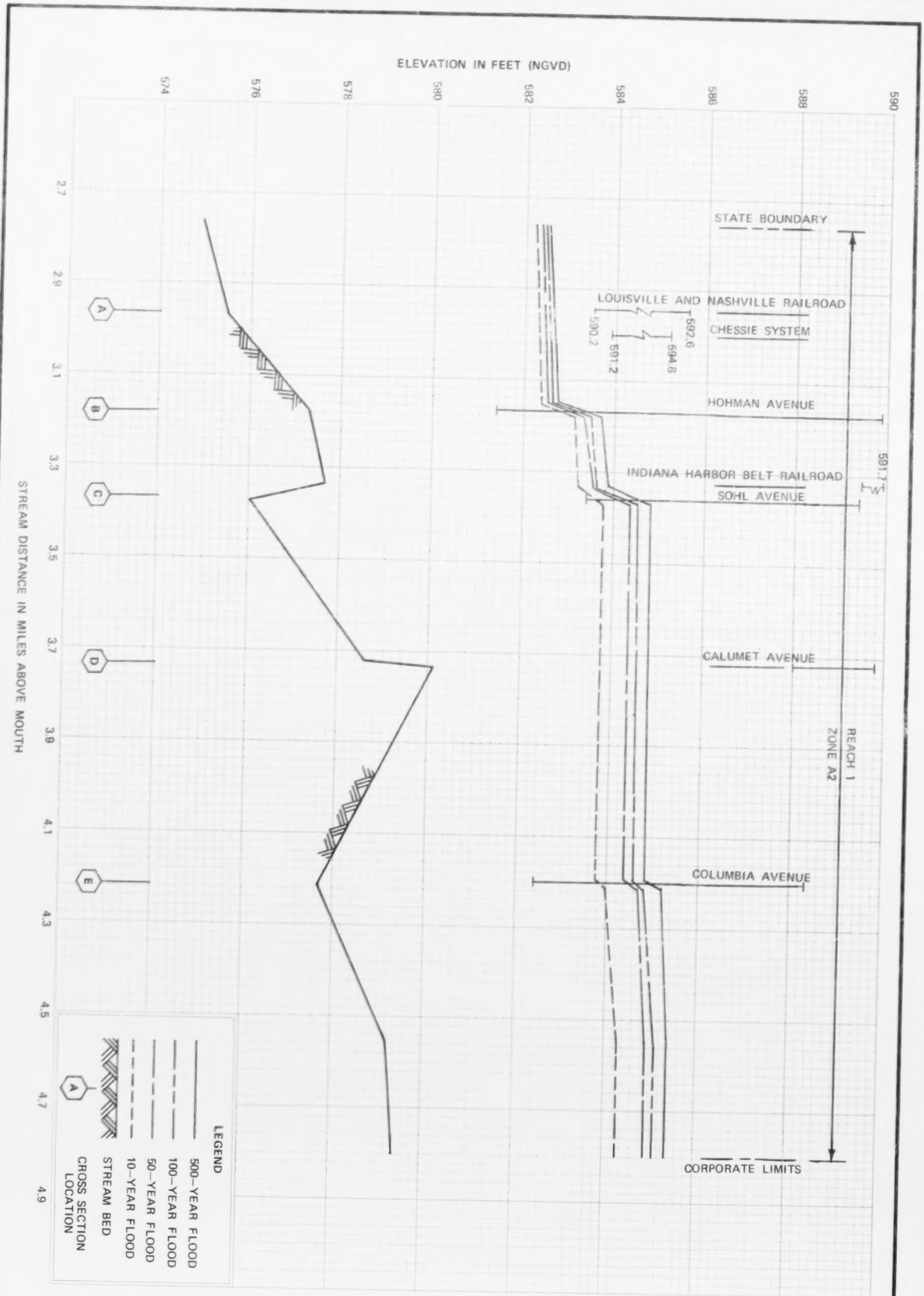

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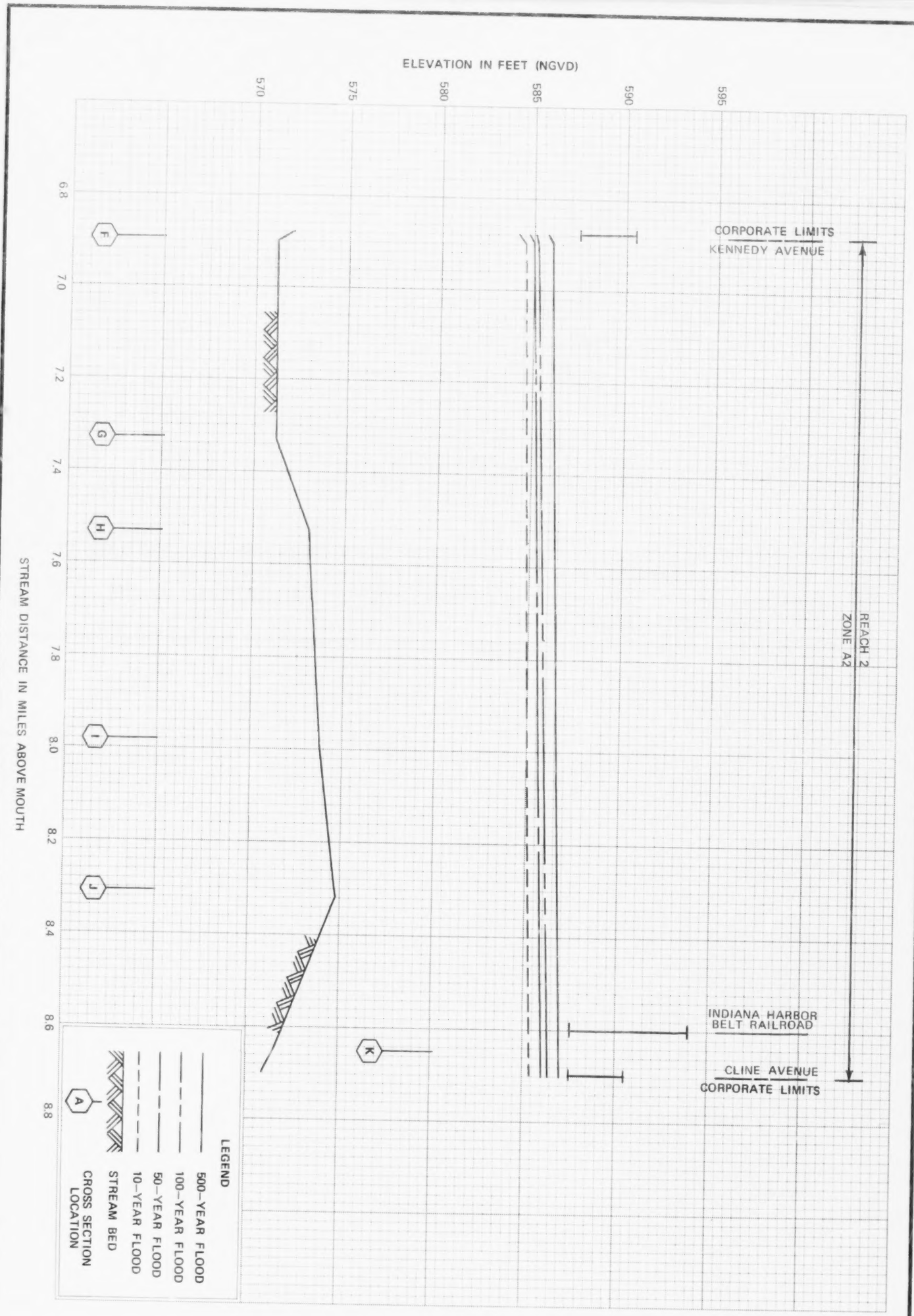

02P

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

CITY OF HAMMOND, IN
(LAKE CO.)

FLOOD PROFILES

GRAND CALUMET RIVER

03P

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

CITY OF HAMMOND, IN
(LAKE CO.)

FLOOD PROFILES

LITTLE CALUMET RIVER - WEST

FLOOD PROFILES

LITTLE CALUMET RIVER - WEST

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

CITY OF HAMMOND, IN
(LAKE CO.)

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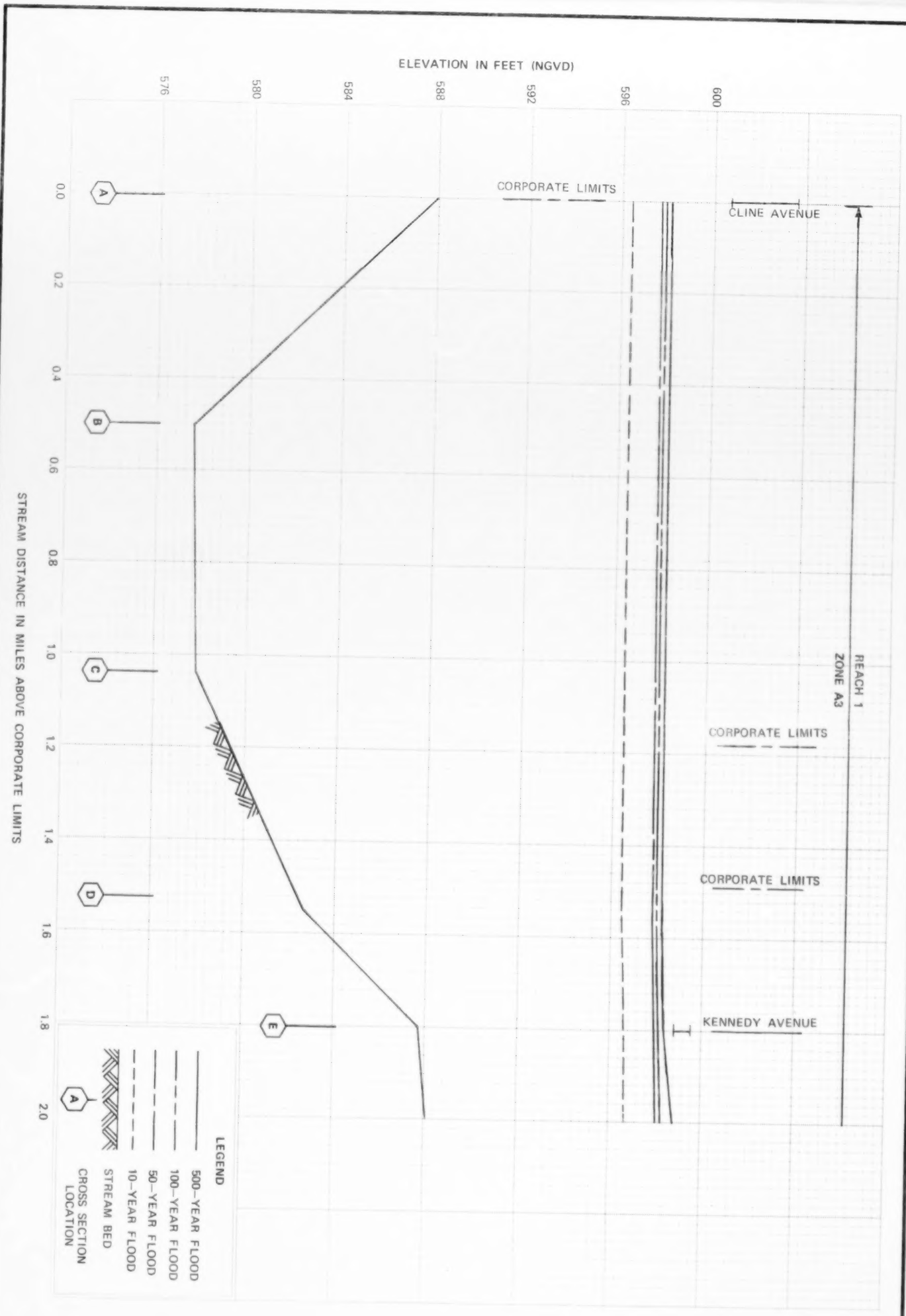

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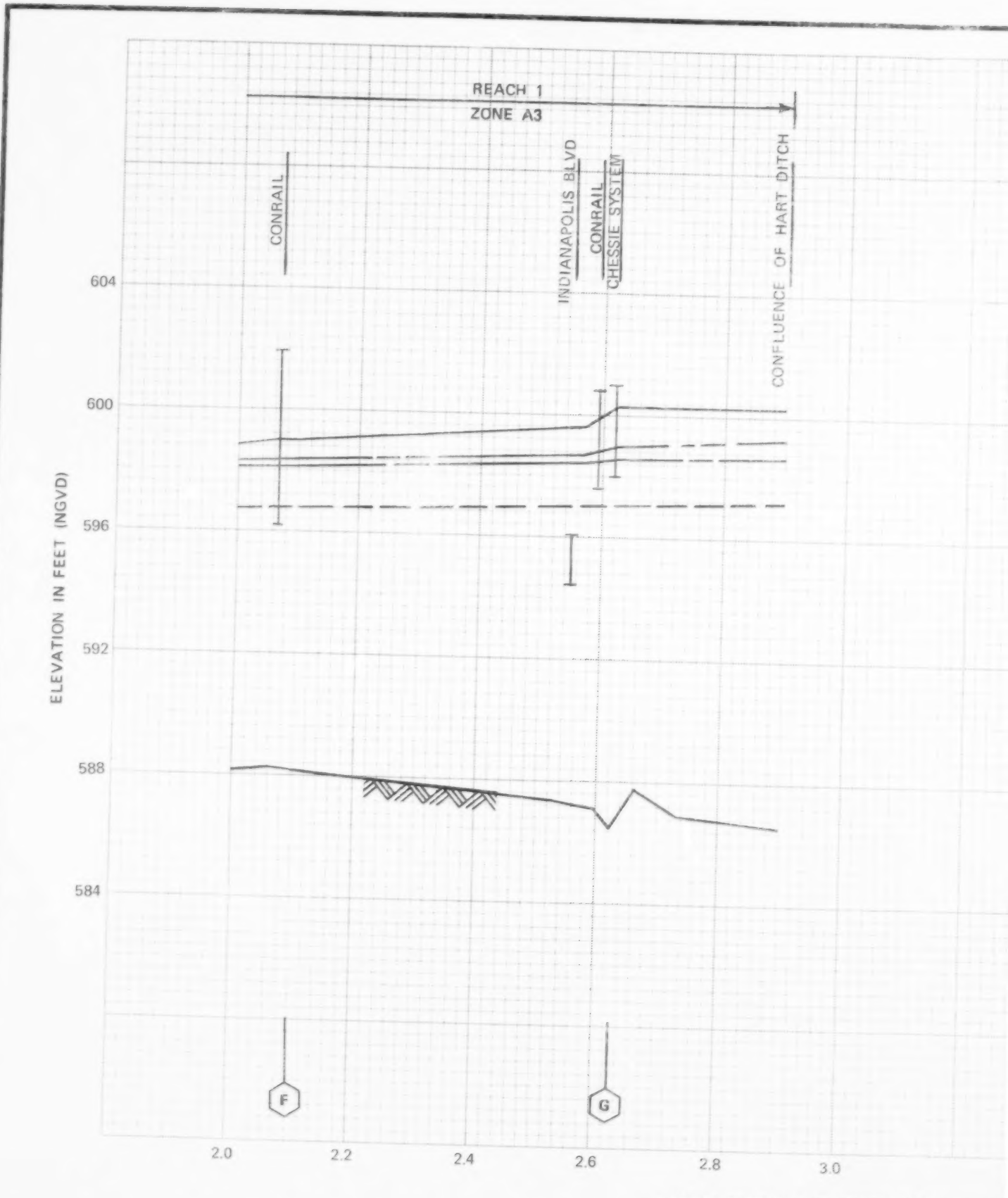
FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

CITY OF HAMMOND, IN
(LAKE CO.)

FLOOD PROFILES

LITTLE CALUMET RIVER-EAST


REACH 1
ZONE A3
CONRAIL
INDIANAPOLIS BLVD
CONRAIL
CHESSIE SYSTEM
CONFLUENCE OF HART DITCH
604
600
596
592
588
584
ELEVATION IN FEET (NGVD)
F
G
2.0
2.2
2.4
2.6
2.8
3.0
STREAM DISTANCE IN MILES ABOVE CORP

LEGEND

500-YEAR FLOOD

100-YEAR FLOOD

50-YEAR FLOOD

10-YEAR FLOOD

STREAM BED

A — CROSS SECTION LOCATION

ATE LIMITS

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

CITY OF HAMMOND, IN
(LAKE CO.)

FLOOD PROFILES

LITTLE CALUMET RIVER-EAST

06P